CGMS XXXII NASA-WP-01
Prepared by NASA
Agenda Item: B.3
Discussed in Plenary

Information on the NASA Research and Development Satellites

This paper provides the NASA response to Action 31.04: New members of CGMS to provide information on their R&D satellites.

Information on the NASA Research and Development Satellites

1. Introduction

A comprehensive list of NASA's Earth Observing satellites is presented in response to the CGMS XXXI action. The information is divided into three segments. The first segment includes NASA's mission which are already in operation, the second segment provides the satellites which are near launch over the next 12-18 months, and the last segment lists satellites under development. All of these satellites are designed to provide a large volume of critical data and products which are being used by multiple sophisticated models to advance our understanding of the Earth as an integrated system. This includes all critical areas under study such as: Atmospheric Composition, Carbon Cycle and Ecosystems, Climate Variability and Change, Earth Surface and Interior, Water and Energy Cycle, and Weather.

2. ESE Research Strategy

NASA's Earth Science Enterprise (ESE) is developing a scientific understanding of the Earth system and its response to natural and human-induced changes to enable improved prediction capability for climate, weather, and natural hazards. The ESE has an end-to-end strategy to ensure that all the information, understanding, and capabilities derived from its research program achieve maximum usefulness for the scientific and decision-making communities. Increasing our knowledge of the Earth system is the goal of the ESE's Research Program, which is complemented by the ESE's Applications Program and Technology Program.

The Earth Science Enterprise has defined its research strategy around a hierarchy of scientific questions. At the highest level, the Enterprise is attempting to provide an answer to one overarching question:

How is the Earth changing and what are the consequences for life on Earth?

The magnitude and scope of this question are too large to allow a simple answer, requiring a lower tier of questions that provide the conceptual approach that the ESE is taking to improve our knowledge of the Earth system:

Variability: ***How is the global system changing?***

Forcing: ***What are the primary forcings of the Earth system?***

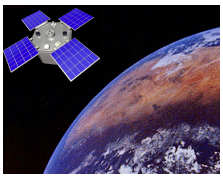
Response: ***How does the Earth system respond to natural and human-induced changes?***

Consequence: ***What are the consequences of change in the Earth system for human civilization?***

Prediction: ***How well can we predict future changes in the Earth system?***

3.1 Satellites in Operation

ACRIMSAT (Active Cavity Radiometer Irradiance Monitor Satellite)



ACRIMSAT measures total solar irradiance. By studying incoming solar radiation and adding measurements of ocean and atmosphere currents and temperatures as well as surface temperatures, improved climate models will be generated.
APPLICATIONS: carbon management, energy management, public health.
LAUNCH:

- Date: December 20, 1999

ORBIT:

- Altitude: 716 km
- Inclination: 98.13 degrees
- Period: 99 minutes
- Sun-Synchronous

DESIGN LIFE:

- 5 years

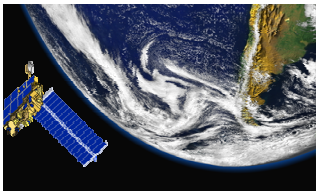
INSTRUMENT:

- ACRIM III (Active Cavity Radiometer Irradiance Monitor III)

MEASUREMENTS:

- Characteristics and variability of solar radiation

Terra (Measurement of Earth's climate system)



The Terra satellite provides global data on the state of the atmosphere, land, and oceans, as well as their interactions with solar radiation and with one another. Japan, Canada, and the U.S. have provided instruments for this mission.
APPLICATIONS: agricultural efficiency, air quality, carbon management, coastal management, community growth, homeland security, invasive species, public health, water management.
LAUNCH:

- Date: December 18, 1999

ORBIT:

- Altitude: 705 km
- Inclination: 98.2 degrees
- Period: 99 minutes
- Repeat Cycle: 16 days
- Sun-Synchronous

DESIGN LIFE:

- 5 years

INSTRUMENTS:

- CERES (Clouds and the Earth's Radiant Energy System)
- MISR (Multi-angle Imaging Spectro-Radiometer)
- MODIS (Moderate Resolution Imaging Spectroradiometer)
- MOPITT (Measurements of Pollution in the Troposphere)
- ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer)

MEASUREMENTS:

- Surface bi-directional reflectance distribution functions and aerosols
- Carbon monoxide and methane in the troposphere
- High-resolution land surface temperature, emissivity, reflectance, and elevation
- Earth's radiation budget and atmospheric radiation
- Terrestrial ecosystem and ocean productivity

Jason-1 (Ocean surface topography)

Jason-1 is a joint mission between France and the U.S. to monitor global ocean circulation, to improve global climate predictions, and to monitor events such as El Niño Southern Oscillation conditions and ocean eddies. This is a systematic measurement follow-on mission to TOPEX/POESIDON.
APPLICATIONS: coastal management, disaster management.
LAUNCH:

- Date: December 7, 2001

ORBIT:

- Altitude: 1,336 km
- Inclination: 66 degrees
- Period: 122.4 minutes
- Repeat Cycle: 10 days
- Non-Sun-Synchronous

DESIGN LIFE:

- 5 years

INSTRUMENTS:

- Laser retroreflector array
- Poseidon-2 solid state radar altimeter
- DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite) receiver
- Jason Microwave Radiometer

- BlackJack GPS Receiver tracking system

MEASUREMENTS:

- Brightness temperature
- Water vapor content
- Liquid water content
- Ocean topography

Aqua (Collects information about the Earth's water cycle)

Aqua acquires precise atmospheric and oceanic measurements to provide a greater understanding of their role in the Earth's climate and its variations. The satellite's instruments provide regional to global land cover, land cover change, temperature and moisture profiles, and atmospheric constituents.

APPLICATIONS: agricultural efficiency, air quality, carbon management, coastal management, homeland security, invasive species, public health, water management.

LAUNCH:

- Date: May 4, 2002

ORBIT:

- Altitude: 705 km
- Inclination: 98.2 degrees
- Period: 99 minutes
- Repeat Cycle: 16 days
- Sun-Synchronous

DESIGN LIFE:

- 6 years

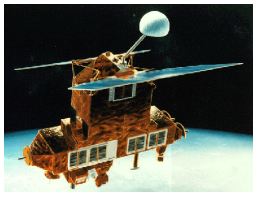
INSTRUMENTS:

- AMSR-E (Advanced Microwave Scanning Radiometer-EOS)
- AIRS (Atmospheric Infrared Sounder)
- AMSU-A (Advanced Microwave Sounding Unit-A)
- CERES (Clouds and the Earth's Radiant Energy System)
- HSB (Humidity Sounder for Brazil)
- MODIS (Moderate Resolution Imaging Spectroradiometer)

MEASUREMENTS**:**

- Sea surface and atmospheric temperature
- Cloud cover and properties and water vapor profile
- Vegetation dynamics
- Snow and ice cover
- Radiative energy flux
- Surface temperature
- Fire monitoring

ERBS (Earth Radiation Budget Satellite)



The ERBS mission is to investigate how energy from the Sun is absorbed and re-emitted by the Earth. Observations from ERBS are also used to determine the effects of human activities (such as burning fossil fuels and the use of CFCs) and natural occurrences (such as volcanic eruptions) on the Earth's radiation balance *(system is only partially operational.)*

APPLICATIONS: air quality, community growth, energy management, public health.

LAUNCH:

- Date: October 5, 1984

ORBIT:

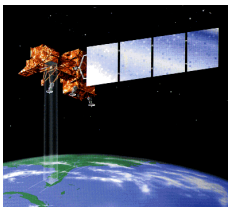
- Altitude: 585 km
- Inclination: 57 degrees
- Period: 96.3 minutes
- Non-Sun-Synchronous

DESIGN LIFE:
- 1 – 2 years (exceeded)

INSTRUMENTS:
- ERBE (Earth Radiation Budget Experiment)
- SAGE II (Stratospheric Aerosol Gas Experiment)

MEASUREMENTS**:**
- Regional and global coverages of radiant flux, albedo, and solar incidence
- Global atmospheric aerosols, ozone, NO2, and water vapor

Landsat 7 (Acquires 30 meter resolution imagery of the Earth)



NASA's Landsat provides well-calibrated, multispectral, moderate resolution, substantially cloud-free, sunlit digital images of the Earth's continental and coastal areas with global coverage on a seasonal basis using the Enhanced Thematic Mapper Plus instrument. NASA developed and launched the system and operated it until transferring operations over to the U.S. Geological Survey in 2000.
APPLICATIONS: agricultural efficiency, air quality, aviation safety, carbon management, coastal management, energy management, homeland security, invasive species, public health, water management.

LAUNCH:
- Date: April 15, 1999

ORBIT:
- Altitude: 705 km (at the equator)
- Inclination: 98.2 degrees
- Period: 98.9 minutes
- Repeat Cycle: 16 days
- Sun-Synchronous

DESIGN LIFE:
- 5 years

INSTRUMENTS:
- ETM+ (Enhanced Thematic Mapper Plus)

MEASUREMENTS:
- Land cover and land use change
- Vegetation dynamics

NMP EO-1 (New Millennium Program Earth Observing-1)

EO-1 is demonstrates and validates advanced technology instruments, spacecraft systems, and mission concepts in flight. It has returned scientific data as a by-product of its testing to support land cover change, ecosystem responses, and atmospheric constituents.
APPLICATIONS: agricultural efficiency, air quality, carbon management, coastal management, invasive species, water management.

LAUNCH:
- Date: November 21, 2000

ORBIT:
- Altitude: 705 km circular
- Inclination: 98.7 degrees
- Period: 98.8 minutes
- Repeat Cycle: 16 days
- Sun-Synchronous

DESIGN LIFE:
- 2 years (exceeded)

INSTRUMENTS:
- ALI (Advanced Land Imager)
- Hyperion
- LAC (Linear Etalon Imaging Spectrometer Array (LEISA) Atmospheric Corrector)

MEASUREMENTS:
- Land cover and land use change

- Hyperspectral Vis-SWIR
- Vegetation dynamics
- Water vapor profile for atmospheric correction

ICESat (Ice, Cloud, and Land Elevation Satellite)

ICESat (Ice, Cloud, and land Elevation Satellite) measures ice sheet topography, ice sheet elevation changes, cloud and aerosol heights, as well as land topography and vegetation characteristics. The surface topograpy and its variability measurements will provide estimates of the Earth's great ice sheets to changes in sea level. It will also provide cloud property information not otherwise available from passive sensors by processing the altimeter data throughout its orbit, including data coverage of high ice clouds common over polar areas, a land-topography dataset, and polar coverage over ice sheets.

APPLICATIONS: air quality, carbon management, coastal management, disaster management, invasive species.

LAUNCH:

- Date: January, 2003

ORBIT:

- Altitude: 600 km circular
- Inclination: 94 degrees
- Period: 96.7 minutes
- Repeat Cycle: 183 days
- Non-Sun-Synchronous

DESIGN LIFE:

- 3 years

INSTRUMENTS:

- Geo-science Laser Altimeter System
- GPS BlackJack receiver

MEASUREMENTS:

- Land, ice, and sea ice topography
- Cloud height

QuikSCAT (Quick Scatterometer)

QuikSCAT measures sea-surface wind speed and direction data for global climate research and operational weather forecasting and storm warning. QuikSCAT data is currently being used by NOAA and the Navy for operational weather prediction.

APPLICATIONS: air quality, aviation safety, coastal management, disaster management.

LAUNCH:

- Date: June 19, 1999

ORBIT:

- Altitude: 803 km
- Inclination: 98.6 degrees
- Period: 102 minutes
- Sun-Synchronous

DESIGN LIFE:

- 3 years (exceeded)

INSTRUMENTS:

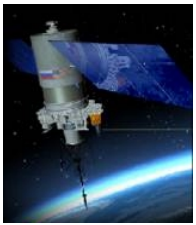
- SeaWinds

MEASUREMENTS:

- Sea surface wind velocity and wind direction
- Sea ice distribution

SAGE III (Stratospheric Aerosol and Gas Experiment)

SAGE III is a joint mission between NASA and the Russian Space Agency that is one of nine experiments on the Russian Meteor-3M spacecraft.



APPLICATIONS: air quality, disaster management, energy management.
LAUNCH:
- Date: December 10, 2001

ORBIT:
- Altitude: 1,020 ±20 km
- Inclination: 99.64 degrees
- Period: 105.3 minutes
- Sun-Synchronous

DESIGN LIFE:
- 5 years

MEASUREMENTS:
- Transmission, Aerosol, Ozone, NO2, Water Vapor, NO3, Chlorine Dioxide, Temperature, Pressure, and Cloud Presence Profiles
- Uses a laser retro-reflector array

SeaWinds(Geographic coverage of ocean wind speed and direction)

SeaWinds is a specialized microwave radar that measures near-surface wind velocity (both speed and direction) under all weather and cloud conditions over Earth's oceans. SeaWinds is a twin sister to the QuikSCAT sensor and is flying on Japan's ADEOS II spacecraft to provide similar observations beyond the QuikSCAT mission.
APPLICATIONS: air quality management, aviation safety, coastal management, disaster management.
LAUNCH:
- Date: December 14, 2002

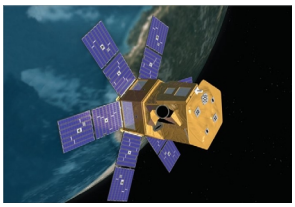
ORBIT:
- Altitude: 803 km
- Inclination: 98.6 degrees
- Period: 101 minutes
- Repeat Cycle: 4 days
- Sun-Synchronous

DESIGN LIFE:
- 5 years

INSTRUMENTS:
- Radar Scatterometer

MEASUREMENTS:
- Sea surface wind velocity and wind direction
- Sea ice distribution
- Vegetation distribution

SORCE (Solar Radiation and Climate Experiment)



SORCE is a NASA-sponsored project with the University of Colorado's Laboratory for Atmospheric and Space Physics in Boulder. It will provide total irradiance measurements and the full spectral irradiance measurements required by climate studies to understand the role of the Sun's variations on the Earth's climate. This is a continuation of ACRIMSAT measurements.
APPLICATIONS: air quality, energy management.
LAUNCH:
- Date: January 25, 2003

ORBIT:
- Altitude: 600 km
- Inclination: 40 degrees
- Non-Sun-Synchronous

DESIGN LIFE:
- 5 years

INSTRUMENTS:
- XPS (Extreme Ultraviolet (XUV) Photometer System)

- TIM (Total Irradiance Monitor)
- SIM (Spectral Irradiance Monitor A&B)
- SOLSTICE (Solar Stellar Irradiance Comparison Experiment A&B)

MEASUREMENTS:

- Solar spectral irradiance
- Earth Energy Budget
- Solar ultraviolet irradiance
- Solar XUV irradiance
- Total solar irradiance

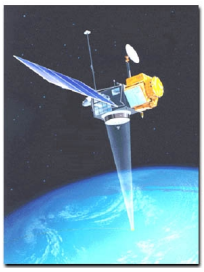
INSTRUMENTS:

- XPS (Extreme Ultraviolet (XUV) Photometer System)
- TIM (Total Irradiance Monitor)
- SIM (Spectral Irradiance Monitor A&B)
- SOLSTICE (Solar Stellar Irradiance Comparison Experiment A&B)

MEASUREMENTS:

- Solar spectral irradiance
- Earth Energy Budget
- Solar ultraviolet irradiance
- Solar XUV irradiance
- Total solar irradiance

TOPEX/Poseidon (Topographic Experiment/Poseidon)



TOPEX/Poseidon is a joint mission between France and the U.S. to monitor global ocean circulation, to improve global climate predictions, and to monitor events such as El Niño Southern Oscillation conditions and ocean eddies.
APPLICATIONS: carbon management, coastal management, disaster management, homeland security.

LAUNCH:

- Date: August 10, 1992

ORBIT:

- Altitude: 1,336 km
- Inclination: 66 degrees
- Period: 112 minutes
- Repeat Cycle: 10 days
- Non-Sun-Synchronous

DESIGN LIFE:

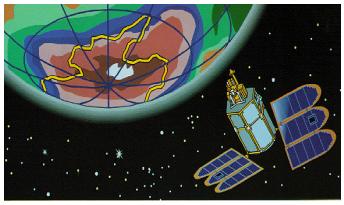
- 5 years(exceeded)

INSTRUMENTS:

- Microwave radiometer
- GPS receiver
- Laser retroreflector array
- Dual frequency NASA radar altimeter
- Single frequency CNES (Centre National d'Etudes Spatiales) radar altimeter
- DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite) receiver

MEASUREMENTS:

- Ocean topography
- Brightness temperature



TOMS – EP (Total Ozone Mapping Spectrometer – Earth Probe)

TOMS – EP provides global measurements of total column ozone and its variation on a daily basis.
APPLICATIONS: air quality, public health.

LAUNCH:

- Date: July 2, 1996

ORBIT:

- Altitude: 740 km

- Inclination: 98.385 degrees
- Period: 104.4 min
- Sun-Synchronous

DESIGN LIFE:
- 2 years (exceeded)

INSTRUMENTS:
- TOMS (Total Ozone Mapping Spectrometer)

MEASUREMENTS:
- Aerosol index
- Ozone content
- Reflectivity
- Erythemal UV exposure

SRTM (Shuttle Radar Topography Mission)

The Shuttle Radar Topography Mission is a joint project between NASA, NIMA, and the German and Italian space agencies to map the world in three dimensions. SRTM flew onboard a Space Shuttle mission, and although data acquisition has been completed, data processing continues.
APPLICATIONS: aviation safety, coastal management, community growth, disaster management, homeland security.

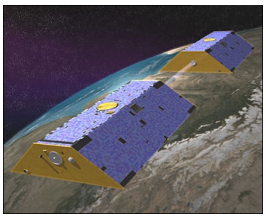
ON-ORBIT:
- Date: February 11, 2000

ORBIT:
- Altitude: 233 km
- Inclination: 57 degrees
- Mission duration: 11 days

INSTRUMENTS:
- X-SAR (X-Band Synthetic Aperture Radar)
- SIR-C (Spaceborne Imaging Radar-C)
- GPS BlackJack receiver

MEASUREMENTS:
- Gridded heights of 80% of the Earth's surface
- Elevation or surface-change information

GRACE (Gravity Recovery and Climate Experiment)



GRACE is a cooperative mission with Germany to obtain an accurate global and high-resolution determination of both the static and the time-variable components of the Earth's gravity field.
APPLICATIONS: aviation safety, coastal management, disaster management.

LAUNCH:
- Date: March 17, 2002

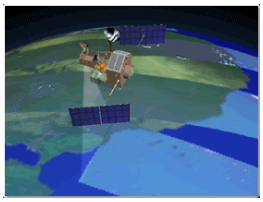
ORBIT:
- Altitude: 300-500 km
- Inclination: 89 degrees
- Non-Sun-Synchronous, near-polar

DESIGN LIFE:
- 5 years

INSTRUMENTS:
- Star Camera Assembly
- GPS BlackJack Receiver
- Instruments Processing Unit
- Laser Retro-Reflector Assembly
- K-Band Ranging Instruments
- SuperSTAR Accelerometers

MEASUREMENTS:
- Gravitational field
- GPS atmospheric and ionospheric limb sounding

TRMM (Tropical Rainfall Measuring Mission)



TRMM is a joint mission between NASA and the National Space Development Agency (NASDA) of Japan to measure tropical rainfall and the associated release of energy that helps to power the global atmospheric circulation shaping both weather and climate around the globe.
APPLICATIONS: air quality management, aviation safety, disaster management, invasive species management, public health, water management and conservation
LAUNCH:

- Date: November 27, 1997

ORBIT:

- Altitude: 402 km
- Inclination: 35 degrees
- Period: 91 minutes
- Non-Sun-Synchronous

DESIGN LIFE:

- 3 years (exceeded)

INSTRUMENTS:

- CERES (Clouds and the Earth's Radiant Energy System)
- LIS (Lightning Imaging Sensor)
- TMI (TRMM Microwave Imager)
- Precipitation Radar
- VIRS (Visible and Infrared Scanner)

MEASUREMENTS:

- Earth's radiation budget and atmospheric radiation
- 3-D rainfall distribution over land and oceans
- Cloud radiation, cloud distribution and height, rain estimates from brightness temperature
- Lightning distribution and variability over the Earth

UARS (Upper Atmosphere Research Satellite)

UARS is the first NASA mission that carries out a systematic, comprehensive study of the stratosphere and furnishes important new data on the mesosphere and thermosphere. The United Kingdom, Canada, and France provided some of the instruments for this mission.
APPLICATIONS: air quality management, carbon management, community growth, energy forecasting, public health.
LAUNCH:

- Date: September 15, 1991

ORBIT:

- Altitude: 585 km
- Inclination: 57 degrees
- Period: 96.7 minutes
- Non-Sun-Synchronous

DESIGN LIFE:

- 3 years (exceeded)

INSTRUMENTS:

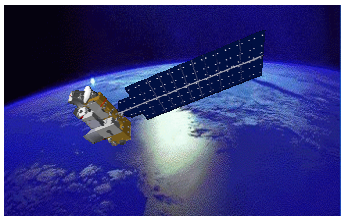
- ISAMS (Improved Stratospheric and Mesospheric Sounder)
- MLS (Microwave Limb Sounder)
- HALOE (Halogen Occultation Experiment)
- HRDI (High Resolution Doppler Imager)
- WIND II (Wind Imaging Interferometer)
- ACRIM (Active Cavity Radiometer Irradiance Monitor)
- SOLSTICE (Solar-stellar Irradiance Comparison Experiment)
- SUSIM (Solar Ultraviolet Spectral Irradiance Monitor)
- PEM (Particle Environment Monitor)
- CLAES (Cryogenic Limb Array Etalon Spectrometer)

MEASUREMENTS**:**

- Energetic electron atmospheric energy input
- Vertical profiles of species concentrations
- Particle characterization
- Mapping of atmospheric winds
- Solar ultraviolet irradiance and Solar UV flux as a function of time
- Ambient geomagnetic field

3.2 Satellites Near Launch

Aura (Measure Earth's ozone, air quality and climate)



Aura will host a suite of scientific instruments designed to make the most comprehensive measurements of atmospheric trace gases ever undertaken. The mission will measure ozone, aerosols, and several key atmospheric constituents that play an important role in atmospheric chemistry, air quality, and climate. The United Kingdom and The Netherlands are providing some of the instruments for this mission.
Applications: air quality, carbon management, energy management, public health.
LAUNCH:

- Date: June 19, 2004

ORBIT:

- Altitude: 705 km
- Inclination: 98.2 degrees
- Period: 100 minutes
- Repeat Cycle: 16 days
- Sun-Synchronous, Polar

DESIGN LIFE:

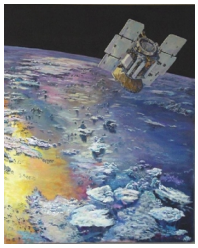
- 6 years

INSTRUMENTS:

- OMI (Ozone Monitoring Instrument)
- MLS (Microwave Limb Sounder)
- TES (Tropospheric Emission Spectrometer)
- HIRDLS (High Resolution Dynamics Limb Sounder)

MEASUREMENTS:

- Molecular species distribution
- Aerosol index, ozone content, reflectivity, erythemal UV exposure, surface radiance
- Temperature and the locations of polar stratospheric clouds and cloud tops
- Water vapor content
- Liquid water content



CloudSAT (Measurements of global cloud properties)

CloudSAT, a cooperative mission with Canada, will use advanced radar to "slice" through clouds to see their vertical structure, providing a completely new observational capability from space. CloudSAT will look at the structure, composition, and effects of clouds and will be one of the first satellites to study clouds on a global basis**.**
APPLICATIONS: air quality, aviation safety, disaster management, energy management, water management.
LAUNCH:

- Date: April 2005

ORBIT:

- Altitude: 705 km
- Inclination: 98.2 degrees
- Period: 99 minutes
- Sun-Synchronous

DESIGN LIFE:

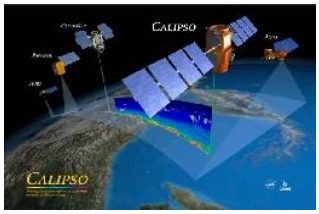
- 2 years

INSTRUMENTS:

- CPR (Cloud Profiling Radar)

MEASUREMENTS:
Cloud properties

CALIPSO
(Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations)



CALIPSO is a cooperative mission with France that will provide key measurements of aerosol and cloud properties needed to improve climate predictions. Aqua and CloudSAT will fly in formation with CALIPSO to provide a comprehensive characterization of the structure and composition of clouds and their effects on climate under all weather conditions. This comprehensive set of measurements is essential for accurate quantification of global aerosol and cloud radiative effects to understand their role in the formation and variation of Earth's climate.
APPLICATIONS: air quality, energy management, public health, water management.
LAUNCH:

- Date: April 2005

ORBIT:

- Altitude: 705 km
- Inclination: 92 degrees
- Sun-Synchronous

DESIGN LIFE:

- 3 years

INSTRUMENTS:

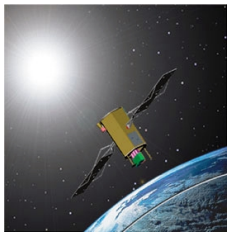
- High-resolution wide field camera
- Polarization sensitive LIDAR
- Imaging infrared radiometer

MEASUREMENTS:

- Aerosol and cloud properties
- Radiative fluxes
- Atmospheric states

3.3 Satellites Under Development

OCO (Orbiting Carbon Observatory)



The Orbiting Carbon Observatory (OCO) provides space-based observations of atmospheric carbon dioxide (CO2), the principal anthropogenic driver of climate change. This mission uses mature technologies to address NASA's highest priority carbon cycle measurement requirement. OCO generates the knowledge needed to improve projections of future atmospheric CO2.
APPLICATIONS: air quality, carbon management, public health.
LAUNCH:

- Date: August 2007

ORBIT:

- Altitude: 705 km
- Inclination: 98.2 degrees
- Polar, sun-synchronous

DESIGN LIFE:

- 2 years

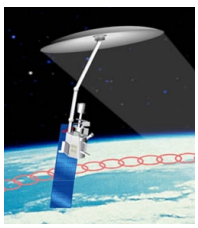
INSTRUMENTS:

- 3 grating infrared spectrometers

MEASUREMENTS:

- Global atmospheric carbon dioxide

HYDROS (The Hydrosphere State Mission)



HYDROS will provide the first global views of Earth's changing soil moisture and land surface freeze/thaw conditions, leading to breakthroughs in weather and climate prediction and in the understanding of processes linking water, energy, and carbon cycles.
APPLICATIONS: water management, energy management, carbon management
LAUNCH:

- Date: December 2006

ORBIT:

- 6AM/6PM sun-synchronous orbit at km, for a 2-year mission.

DESIGN LIFE:

- 2 years

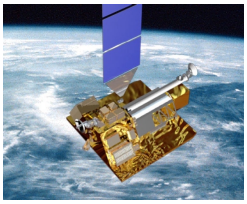
INSTRUMENTS:

- L-band radar and radiometer using one deployable antenna;
- Radiometer from GSFC
- Radiometer from ASI (Italian)
- Antenna from CSA

MEASUREMENTS**:**

- Hydroclimatology of the soil moisture at 40 km
- Hydrometerology of the soil moisture at 10 km
- Observe freeze/thaw conditions at 3 km.

GPM (Global Precipitation Measurement)



GPM is a joint mission with the National Space Development Agency (NASDA) of Japan and other international partners. Building upon the success of the Tropical Rainfall Measuring Mission (TRMM) GPM, via a constellation of small satellites, will initiate global precipitation measurement, a key climate factor. Its science objectives are to improve ongoing efforts to predict climate by providing near-global measurement of precipitation, its distribution, and physical processes; to improve the accuracy of weather and precipitation forecasts through more accurate measurement of rain rates and latent heating; and to provide more frequent and complete sampling of the Earth's precipitation.
APPLICATIONS: agricultural efficiency, disaster management, water management.
LAUNCH:

- Date: late 2008

ORBIT:

- Altitude: 400 – 500 km
- Inclination: 65 degrees
- Sun-Synchronous

DESIGN LIFE:

- 3 years

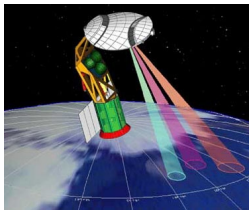
INSTRUMENTS:

- DPR (Dual-frequency Precipitation Radar)
- GMI (GPM Microwave Imager)
- Constellation of passive microwave radiometers

MEASUREMENTS:

- Global precipitation
- Cloud structure and precipitation characteristics including rain rate, cloud type, 3D cloud structure, and drop-size distribution

Aquarius (Global maps of salt concentration of the ocean surface)



Aquarius is a focused satellite mission to measure global sea surface salinity (SSS). Aquarius will resolve missing physical processes that link the water cycle, the climate, and the ocean. The Aquarius science goals are to observe and model the processes that relate salinity variations to climatic changes in the global cycling of water and to understand how these variations influence the general ocean circulation.
APPLICATION: coastal management.

LAUNCH:
- Date: September 2008

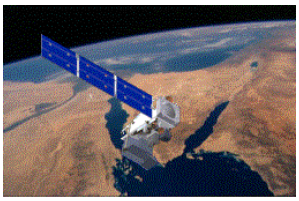
ORBIT:
- Altitude: 600 km
- Repeat Cycle: 8 days
- Sun-Synchronous

DESIGN LIFE:
- 3 years

INSTRUMENTS:
- Radiometer/Scatterometer

MEASUREMENTS:
- Seawater emissivity sensitive to salinity

NPP (NPOESS Preparatory Project)



The NPP is a cooperative project coordinated through the NPOESS Integrated Program Office (IPO) to extend key measurements in support of long-term monitoring of climate trends and of global biological productivity. It extends the measurement series being initiated with EOS Terra and EOS Aqua by providing a bridge between NASA's EOS missions and the National Polar-orbiting Operational Environmental Satellite System (NPOESS).
APPLICATIONS: agricultural efficiency, coastal management, disaster management, energy management, water management

LAUNCH:
- Date: October 2006

ORBIT:
- Altitude: 824 km
- Period: 101 minutes
- Sun-Synchronous

DESIGN LIFE:
- 5 years

INSTRUMENTS:
- VIIRS (Visible Infrared Imaging Radiometer Suite)
- CrIS (Cross-track Infrared Sounder)
- ATMS (Advanced Technology Microwave Sounder)
- OMPS (Ozone Mapping and Profiler Suite)

MEASUREMENTS:
- Atmospheric temperature & water vapor profiles
- Cloud cover, ocean surface temperature, sea ice, land, and atmosphere
- Total column and vertical profile ozone measurements
- Terrestrial ecosystem & ocean productivity

LDCM (Landsat Data Continuity Mission)

The Landsat Data Continuity Mission (LDCM) is a joint NASA-United States Geological Survey (USGS) mission to extend the Landsat record of multispectral, 30-meter resolution, seasonal, global coverage of the Earth's land surface. LDCM provides an opportunity to acquire science data in partnership with private industry. The commercially owned and operated system will follow the Science Data Specification and Data Policy specified by NASA and USGS for Landsat data, while concurrently allowing commercial exploitation of data.
APPLICATIONS: agricultural efficiency, air quality, aviation safety, carbon management, coastal management, energy management, homeland security, invasive species, public health, water management.

LAUNCH:
- Date: TBD

ORBIT:
- Altitude: 705 ±5 km (at the equator)
- Inclination: 98.2 degrees

- Period: 99 minutes
- Sun-Synchronous

DESIGN LIFE:
- 5 years

MEASUREMENTS:
- Land cover and land use change
- Vegetation dynamics

OSTM (Ocean Surface Topography Mission)

OSTM is a cooperative effort between NASA, the National Oceanic and Atmospheric Administration (NOAA), European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), and the Space Agency of France – the Centre National d'Etudes Spatiales (CNES). OSTM will be a follow-on to the Jason-1 mission. Sea surface topography measured by satellite altimeters has numerous applications important to global environmental monitoring, including predicting hurricane intensification, improving tide models, mapping deep ocean bathymetry, monitoring and forecasting El Niño Southern Oscillation, measuring the rate of global sea level rise, and charting surface currents.

APPLICATIONS: coastal management, disaster management.

LAUNCH:
- Date: October 2007

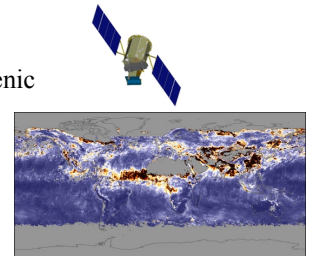
ORBIT:
- Altitude: 1336 km
- Inclination: 66 degrees
- Period: 10 days

DESIGN LIFE:
- 5 years

INSTRUMENTS:
- Wide-swath ocean altimeter (proposed)
- DORIS - Doppler Orbitography and Radiopositioning Integrated by Satellite
- BlackJack real-time space receiver
- Laser retro-reflector array

MEASUREMENTS:
- Sea surface topography

Glory



The Glory Mission, in the framework of the Climate Change Research Initiative (CCRI), is intended to determine the global distribution of natural and anthropogenic aerosols with accuracy and coverage sufficient for a reliable quantification of the aerosol effect on climate, the anthropogenic component of this effect, and the long-term change of this effect caused by natural and anthropogenic factors. It will also provide continued measurement of the total solar irradiance to determine the Sun's direct and indirect effect on climate.

APPLICATIONS: climate impacts, energy management, water management

LAUNCH:
Date: December 2007

ORBIT:
Altitude: 824 km
Period: 101 minutes
Sun-Synchronous
In formation with NPP

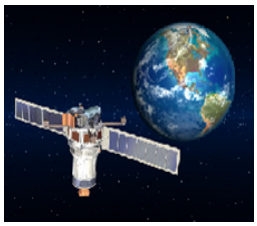
DESIGN LIFE:
3 years

INSTRUMENTS:
APS (Aerosol Polarimetry Sensor)
TIM (Total Irradiance Monitor)

MEASUREMENTS:

Aerosol column optical thickness
Aerosol particle size distribution
Aerosol refractive index
Aerosol single scattering albedo
Cloud particle size distribution
Total solar irradiance

DSCOVR (Deep Space Climate Observatory)



DSCOVR is a cooperative project between the NASA Offices of Earth and Space Science. It is designed to measure how solar radiation affects climate by using the Sun-Earth libration point L1 (1,000,000 miles away from Earth) to make full Earth observations continuously.
APPLICATIONS: agricultural competitiveness, air quality management, carbon management, energy forecasting.
LAUNCH:

- Date: TBD

ORBIT:

- DSCOVR has a 1-million-mile journey to reach L1 (the Lagrange neutral gravity point between the Earth and the Sun) from which it will observe Earth

DESIGN LIFE:

- 2 years

INSTRUMENTS:

- A single-pixel broadband radiometer, NISTAR
- Scripps 9 channel EPIC (Earth Polychromatic Imaging Camera)

MEASUREMENTS:

- Early warning of solar events
- Aerosol index, ozone content, reflectivity, erythemal UV exposure
- Earth's energy balance or radiances and the Earth's albedo